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West Virginia University
Agricultural Experiment Station
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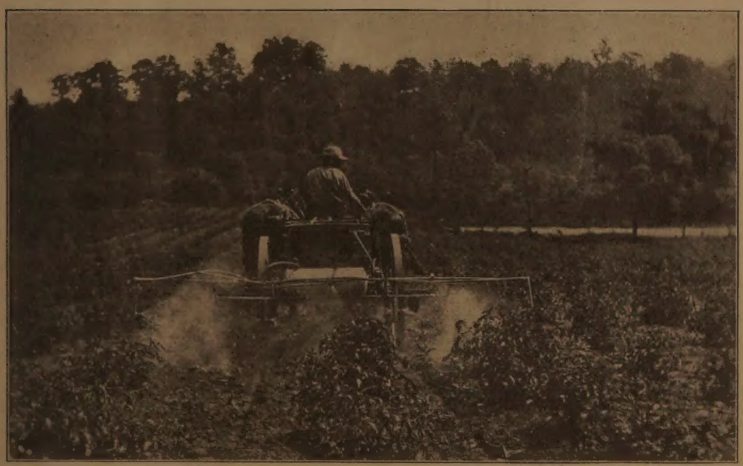
DEPARTMENT OF PLANT PATHOLOGY

Potato and Tomato Diseases



A good outfit for spraying tomatoes and potatoes.

BY

N. J. Giddings.

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POTATO AND TOMATO DISEASES

By N. J. GIDDINGS.

POTATO DISEASES.

Potato growing in West Virginia is just now beginning to receive a fair share of the attention which it deserves. The markets are good and there is within the State a considerable area well adapted to the growth of the crop. It is sometimes maintained, however, that the advantages of good prices and convenient markets are more than offset by the low yields which are secured. Average yields in West Virginia are much lower than they should be but the fault is not entirely with the potatoes, the soil, or the climate. The yield can be considerably increased by **proper and careful** seed selection, and good cultivation and fertilization of the soil help wonderfully.

Climatic conditions constitute a factor which can not be controlled. It is a factor, however, which is vitally important in determining the prevalence and destructiveness of many plant diseases. During the past seven years the department of plant pathology has been making a general study of the potato diseases which occur in West Virginia and it is due to the need and desire for information concerning this subject which led to its being included in this bulletin.

Tip Burn and Sun Scald.—Tip burn and sun scald are very widespread and destructive throughout West Virginia (see Fig. 1). They are due to soil and weather conditions, and are commonly spoken of as physiological troubles. The tip burn, which is especially prevalent, is due to prolonged drought and lack of cultivation. The symptoms of this disease are gradual death and rolling up of the tips and edges of the leaves.

Any diseased or weakened condition is likely to favor the development of this trouble, and plants affected with the Fusarium wilt disease are liable to show a great amount of tip burn.

Flea beetle punctures also aggravate tip burn. It is readily apparent that a leaf which contains numerous punctures and dead areas is far more likely to be injured by unfavorable weather conditions than a good, healthy one.

Persistent, thorough, and careful cultivation is a very important factor in the control of this disease. If the soil is thoroughly prepared before planting and is kept well cultivated and mellow until

after the plants have blossomed, the amount of injury due to tip burn will be very greatly reduced. Spraying with Bordeaux mixture (5-5-50) is of incidental value in controlling this disease, since it helps to keep the plants free from fungous diseases and insect enemies. The planting of potatoes on northerly slopes may sometimes be of benefit by sheltering the plants from the most direct sunlight. The use of potato varieties which are especially resistant to tip burn is another important factor in the control of this disease. The variety Carman appears to be quite resistant under West Virginia conditions, but no very extensive observations have yet been made.

Fig. 1.—Potato tip burn showing tips and edges of leaves burned crisp and brown. Note the punctures made by flea beetles.

Sun scald may often be found upon rapidly growing plants, and is due to excessively bright, hot, sunshine coming immediately after a period of rain. At such times one may often find that some of the younger leaves have a wilted, scalded appearance and, if such leaves are watched, it will be found that they turn brown and dry up in a few days. The sun scald injury may involve the entire leaf, a portion near the edge or tip, or a portion of the tissue near the midrib. In the case of this disease, the abrupt change in temperature, light, and atmospheric moisture causes death of the leaves or leaf parts in a very few hours, while the tip burn develops very slowly. Sun scald is not likely to be generally destructive and there is no specific treatment for it.

Fusarium Wilt and Dry Rot.—(See Fig. 2). Fusarium wilt, due to a fungous parasite, is very generally distributed throughout West Virginia. It is quite common in the Ohio valley, and very heavy losses are occasioned by it. Infection of the potato plant may occur either as a result of using diseased seed, or of planting in a soil which contains the disease. The fungus grows into the roots and stalks, destroying the tissues, absorbing the food and injuring or killing the little veins or ducts which lead from the roots to the leaves. As a result of such injuries, the growth of the plant is prematurely checked;

the leaves show a strong tendency to roll up, develop tip burn, and lose their healthy green color; the lower leaves often drop off leaving much of the stalk bare; the plants sometimes wilt during the middle of a hot day; and the entire plant soon dies. The tubers, of course,

Fig. 2.—Potato Fusarium wilt attacking plants in the foreground.

cannot develop properly and a poor crop of small potatoes is secured from Fusarium infected plants.

The fungus causing the disease frequently grows into the young tubers by way of the stem (see Fig. 3). It may also gain entrance by means of insect injuries or wounds at digging time. Diseased tubers usually show a ring of brown discolored tissue which is most pronounced near the stem end. Infected potatoes are very liable to develop a dry rot in storage. They are also undesirable as seed stock, because the disease will be propagated along with the potatoes and many missing hills may be caused as a result of the young plants' being killed by it.

When considering methods of treatment it must be remembered that the fungus lives over in the soil and that it may also be carried in the seed potatoes. It is difficult to learn how long the fungus will live in the soil, but any field which has borne a diseased crop should not be again planted to potatoes for at least five or six years, if possible. It has been found that the amount of disease can be greatly

reduced by careful seed selection. Tubers should not be used for seed if they show brown discoloration in the flesh for more than one-fourth inch in from the stem end. It is also advisable to disinfect them

Fig. 3.—Fusarium wilt on tubers causing rings of discolored tissue.

with formalin used at the rate of one pint to thirty gallons of water. The cut seed should be allowed to remain in this solution for from one to two hours. The combination of clean soil, clean seed, and seed disinfection will do wonders in reducing the amount of injury from Fusarium wilt.

Storage of the crop in a cool, dry place is the only practical method of preventing infected tubers from developing a serious amount of dry rot.

Bacterial Wilt.—The existence of potato bacterial wilt has not been reported to the Experiment Station during the past seven years but it undoubtedly does occur, since the tomato bacterial wilt, due to the same organism, has been found in several localities. This disease is caused by bacteria which, like the Fusarium fungus, develop in the tissues of the potato plant and injure or clog the lines of communication between roots and leaves so that the plants wilt and die. The symptoms are most noticeable soon after a period of moist, warm weather. The plants sometimes die within a day or two after the first symptoms of wilting, while in other cases they may live for a considerable length of time. After cutting off a diseased plant near the ground with a sharp knife, one may sometimes find tiny drops of grayish exudate on the cut surface. These droplets are full of the bacteria. The disease gains entrance to the tubers through the stem end and may produce a wet rot. Infected tubers usually show a discolored ring near the stem end, and there are likely to

be small drops of exudate from the cut surface as in the case of the diseased stalk. The treatment for this disease consists in the rotation of crops and careful selection of seed.

Black Leg.—Black leg is another bacterial disease (see Fig. 4) affecting the stalks and tubers. The symptoms of this disease are upright growth of leaves and branches, uprolling and yellowing of leaves, and blackening at the base of the stalk. This black discoloration, from which the disease takes its name, is very characteristic and sometimes extends for three or four inches above the ground. Many of the infected plants die before they have formed any tubers.

Fig. 4.—Potato black leg.

Black leg is quite widely distributed throughout West Virginia, but has been reported as destructive in only one or two cases. It is usually noted in the low spots of a potato field, since the organism requires considerable moisture for its development. The selection of a well-drained soil is, therefore, helpful in controlling black leg. The disease is evidently carried over from year to year in the seed potatoes as well as in the soil. Care should therefore be taken to select good, clean seed stock and to discard any tubers which show signs of rot or of internal discoloration. Seed treatment with formalin solution has also been found helpful. Rotation of crops should be practiced.

Early Blight.—The early blight (see Fig. 5) is due to a fungus which attacks the leaves, producing dark brown spots. These spots often show a somewhat concentric ringed appearance. A leaf which has several spots is very liable to become further injured by tip burn, and then die. The disease is found in most sections of the State and has been noted as quite destructive in some fields. Bordeaux mixture (5-5-50) is very effective in controlling early blight, but the vines must be well coated with the spray and should receive not fewer than four or five applications.

Fig. 5.—Early blight showing typical dark brown spots on the leaves.

Fig. 6.—Late blight causing rot of tubers.

Late Blight.—Late blight is a disease which is favored by cool, moist weather. It has been found largely at the higher elevations,

about 2,000 feet in this State. If favorable conditions prevail, it is one of the worst fungous troubles of the potato, and an entire field may be destroyed in a few days' time. The late blight affects leaves, stalks, and tubers. On the leaves it produces spots which have a scalded appearance and which soon involve the entire leaf. In cool, foggy, or rainy weather the fungus may often be found as a white growth on the diseased spots. It frequently gets on the stalks and produces a long, dark, discolored area. Such diseased stalks will usually be killed at the point of attack so that all growth beyond will die. The fungous fruits or spores borne upon diseased potato leaves and stalks are readily carried about the field by man, animals, insects, etc. They are also washed off by rains and are carried down into the soil and thus cause infection of the tubers. The diseased tubers show a cinnamon brown discoloration extending into the flesh a short distance.

It should be noted that the late blight gains entrance through the potato eyes, lenticels, or slight wounds in the skin; whereas, the Fusarium wilt grows out in the underground portions of the stalk and finally enters the tuber at the stem end, or else it may start in wounds. Potatoes affected by the late blight rot alone show a brown

Fig. 7.—Late blight diseased tubers cut open. Note the difference between this disease and Fusarium.

discoloration extending in from the skin; whereas, in the usual cases of Fusarium disease there is a zone of white flesh beneath the skin and then some dark brown or blackish tissue (see Figs. 3, 6, and 7).

Various kinds of secondary rots are liable to get a start in the spots which have been killed by the late blight fungus and these will completely destroy the tubers. The late blight is carried over from year to year by means of diseased seed or, possibly, by the growth of volunteer plants from some infected potatoes which were left in the field.

The potatoes in an infected field should not be dug until the tops are entirely dead and well dried out, as the disease is very easily carried to the tubers by getting them in contact with the diseased tops. The crop harvested from such a field should be dried as carefully as possible and placed in a cool, dry storage cellar. This disease may spread to some extent in storage if there is sufficient moisture. The affected spots on tubers which have been in storage will frequently become sunken and the surface will sometimes assume a shiny, bluish-brown color but the characteristic cinnamon brown color will be found by cutting into the spot.

The potato late blight may be almost entirely controlled by thorough spraying with Bordeaux mixture (5-5-50). The first application should be made when the plants are six to eight inches high, and the field should then be sprayed at two-week intervals until four or five applications have been made. The spraying must be well done if any good results are to be expected. The writer does not feel that any field of half grown potato plants is thoroughly sprayed unless it has received at least one hundred gallons of Bordeaux mixture per acre. Care should also be used in the selection of seed for planting. Any tubers showing evidence of disease should be discarded.

Scab.—Nearly everyone is familiar with the common potato scab which so often makes the tubers rough and unsightly (see Fig. 8). This trouble is produced by a fungus which distorts and destroys the outer tissues of the potato. The scab fungus lives over winter in diseased tubers. It also remains alive in soil in which a crop of scabby potatoes has been grown. An alkaline soil is particularly favorable to the development of this fungus. Applications of lime, ashes, or other alkaline material to a potato field are, therefore, dangerous unless it is certain that the seed and soil are free from scab. There is no practical method of soil treatment now known which will eliminate the fungus from infected ground except that of crop rotation. A field which has grown scabby potatoes should not be used again for root crops for at least five or six years. It has been found that the repeated turning under of green crops such as rye or clover will help to clear a soil from the scab fungus. Seed disinfection should be very generally practiced and is best accomplished by the use of formaldehyde either in the form of a gas or in solution. Since the treatment with gas requires special equipment

and is ordinarily used only in the disinfection of large quantities of potatoes, the details of this method will not be given here. For the liquid treatment, one pint of 40 percent formaldehyde (commonly called formalin) is poured into thirty gallons of water. This solution may be used in any tub or kettle. The seed potatoes should be put into sacks and allowed to soak in the formalin for from one to two hours. However, tubers which are badly diseased should not be used as seed. Disinfection will not make a poor potato good but it will kill all of the disease germs on the surface. The treated seed may be planted at once or it may be dried and placed in sacks again. Care must be exercised, however, so that treated seed will not be put into sacks or bins in which there have been other scabby potatoes unless such sacks or bins are first washed with the disinfectant.

Fig. 8.—Potato scab.

Corrosive sublimate used at the rate of two ounces in fifteen gallons of water is an effective material for the disinfection of seed potatoes, but it can be used only in wooden tubs or barrels, is very poisonous, and has no particular advantage over formaldehyde.

Powdery Scab.—Powdery scab is a comparatively new disease in the United States (see Fig. 9) and its discovery in some important potato growing sections has been the cause of much uneasiness. It affects only the tubers and usually produces raised, pimple-like pustules, which burst open exposing a mass of dark brown, powdery fungus. The difference in appearance between this and the common potato scab is brought out by Figs. 8 and 9. The disease is reported as being very destructive in certain European countries and has been a source of considerable loss in some sections of Canada and the northern United States.

In the spring of 1914 some specimens of powdery scab were found in two lots of seed potatoes which had been shipped into the northern

part of West Virginia. Some infected seed had been planted but at harvesting time no evidence of this disease was found in the crop. In view of this fact and similar observations reported from other southern states, it was thought advisable to learn whether powdery scab was likely to be a destructive trouble under southern conditions. To determine this point, the United States Department of Agriculture procured a lot of badly infected potatoes and distributed them to certain experiment stations. The West Virginia Experiment Station agreed to test some of the seed and it was planted in a field where there was no likelihood of the disease being carried to other fields and where potatoes would certainly not be grown again for a considerable number of years. Forty-three hills were planted in limed soil and thirty-eight hills in unlimed soil. At harvesting time there was not the least sign of powdery scab upon any of the tubers.

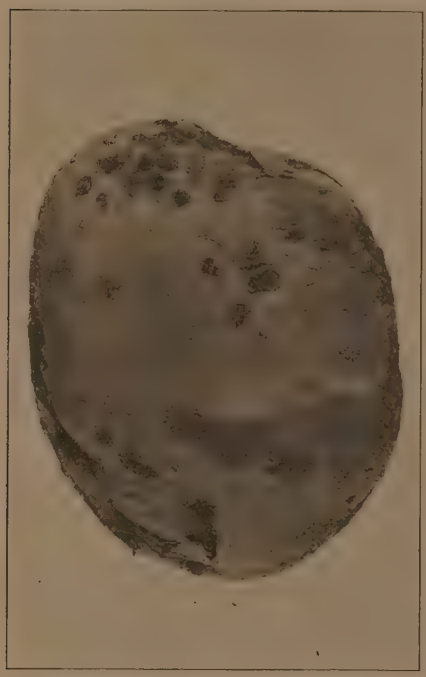

Fig. 9.—Potato powdery scab.

While these experiments indicate that southern conditions are unfavorable to the development of powdery scab, it would still be unwise to assume that it cannot cause us trouble. It is entirely possible that climatic variation might help to establish the powdery scab here during some later season, especially at some of the higher elevations, and it is worth while to use reasonable precautions against it.

Rotation and seed treatment with formaldehyde have been found quite effective in controlling this disease.

Silvery Scurf.—Silvery scurf (see Figs. 10 and 11) is quite widespread but is of somewhat minor importance. It is another of the diseases which attack the surface of the tuber, but fortunately it does not visibly rupture the skin or penetrate the flesh to any extent. It is quite inconspicuous upon the dry potatoes but when they are moistened the disease shows up as a glistening, somewhat

silvery area of variable size. Very small, shiny, black specks may often be distinguished by looking closely at such affected areas. In some cases the entire tuber may be diseased, and badly infected

Fig. 10.—Silvery scurf.

potatoes often shrivel considerably in storage. This loss of moisture through the diseased skin and the possibility of weak germination in diseased seed appear to be the principal injurious effects of silvery scurf. The formaldehyde seed treatment is said to help in controlling this disease.

Rhizoctonia.—It is not unusual to find very small, dark brown bits of material remaining on a potato after it has been thoroughly washed. These little brown places look very much like dirt and are sometimes spoken of as "The dirt that won't wash off". They are in reality a mass of the fungus which has grown together on the surface, and a good magnifying glass would reveal many brown fungous threads near these places on the potato surface. The brown masses of the fungus are quite firmly attached to the potato skin but they may be scraped off with the finger nail or the back of a knife. This disease does not usually cause much injury on the potato tubers themselves, but it sometimes attacks other underground portions of the plant, and the stalk. In such cases, the Rhizoctonia may destroy the tissues to such an extent that the yield of potatoes will be greatly diminished.

This fungus lives over from year to year in the soil and on the tubers. Rotation, careful seed selection, and the treatment of seed with formalin or corrosive sublimate will do much to control the disease. Corrosive sublimate has been found more effective than formalin for the disinfection of potatoes badly affected with this disease. If corrosive sublimate is used, it should be made up at the rate of four ounces in thirty gallons of water, and must be used only in wooden tubs or barrels. The potatoes should be allowed to remain in the solution for about one hour, and thirty gallons should be used to treat not more than fifteen bushels of seed.

Fig. 11.—Enlarged view of silvery scurf on diseased potato.

Spindling-Sprout.—Spindling-sprout is a peculiar disease of the tubers (see Fig. 12) which may sometimes result in much trouble and loss. The exact cause of spindling-sprout is not known, but there is some evidence which indicates that the potatoes produced during a hot, dry season are more likely to show this disease when planted the next spring. A normal potato sprout is stout and thick, while the sprouts from tubers affected by this trouble are long and slender even when grown in good strong light. It is very easy to pick out diseased tubers if they are examined while there are sprouts on them. It has been found that the planting of tubers affected with spindling-sprout will result in a very uneven stand with numerous missing hills and many weak plants. The plants from such tubers never become strong and produce only a few, small potatoes.

Seed selection in order to avoid the use of any potatoes which show symptoms of this disease will help very materially in increasing the yield of good potatoes.

Fig. 12.—Spindling-sprout disease.

Potato Spraying Experiments.

It seemed desirable to test the value of Bordeaux mixture prepared in different ways and of certain other spray materials for the control of potato diseases. In 1909 the plant pathology department undertook some experiments along that line. The results of the work for the seasons of 1909, 1910, and 1911 have already been published in the reports of the West Virginia Experiment Station, and will be merely summarized here.

TABLE I.—Comparison of the Average Marketable Yields on Potato Plots Sprayed with Bordeaux Mixture (5-5-50) and on Unsprayed Checks Plots.

Year	Location of Plots	Yields on Sprayed Plots (Bushels)	Yields on Unsprayed Plots (Bushels)	Increase Due to Spraying	
				Bushels	Percent
1909	Morgantown	87.5	57.0	30.5	53.5
1910	Reedsville	82.3	59.1	23.2	39.3
1911	Moundsville	48.8	42.9	5.9	13.7
1912	Moundsville	107.5	96.0	11.5	12.0
1912	Morgantown	93.7	82.0	11.7	14.3
1913	Morgantown	80.4	72.4	8.0	11.0

These experiments were all conducted upon a commercial scale. There was very little of either early blight or late blight in any of the fields, yet there was a sufficient increase in yield of marketable tubers to warrant the use of the spray. It is not uncommon to learn of cases in which someone has lost a large part of his potato crop through late blight, which disease could be almost entirely controlled by thorough and systematic spraying.

Commercial lime sulphur solution as a potato spray was tested at the rate of one gallon to forty gallons of water. This material was distinctly injurious to potato foliage and the effect upon yield is brought out by the following table:

TABLE II.—Comparison of the Average Marketable Yields on Potato Plots Sprayed with Commercial Lime Sulphur and on Unsprayed Check Plots.

Year	Yields on Sprayed Plots (Bushels)	Yields on Unsprayed Plots (Bushels)	Decrease Due to Spraying	
			Bushels	Percent
1912	53.2	82.0	28.8	35.0
1913	53.2	72.4	19.2	26.5

The concentrated commercial lime sulphur solution has sometimes been sold in West Virginia as a potato spray. Our experiments together with trials conducted at other experiment stations have conclusively shown that this material is not desirable for use on potatoes. The most practical spray material that has yet been found for use on potato foliage is the home-made Bordeaux mixture (5-5-50).

General Recommendations

1. Select the seed carefully. Seed selection in the field is undoubtedly a valuable and practical method of keeping up or improving the quality of potatoes and keeping down certain rather serious forms of disease. The general subject of seed selection will not be taken up in detail here. If seed stock is purchased, care should be taken to avoid any badly diseased potatoes which may make trouble in the potato field for years to come.

In this connection it should be noted that certain growers in some of the northern states are offering various grades of certified seed potatoes. It must not be thought that such seed are guaranteed to be free from all disease. Any certified seed should be accompanied by a statement from a state inspector indicating that the potatoes in question do not contain more than a certain percentage of some specific diseases such as late blight, Fusarium, or scab, and should state what diseases were not found. The use of high grade certified seed is especially recommended for sections where new ground is

being devoted to the growing of potatoes. Anyone interested in securing certified seed or desiring further information on this subject should write the West Virginia Agricultural Experiment Station.

It is a good plan to cut all tubers used for seed, and to discard any which show discoloration. Do not plant tubers which produce weak spindling sprouts.

2. Disinfect seed potatoes either with formaldehyde or corrosive sublimate. This is a good general rule because it will help to reduce the amount of injury from black leg, scab, powdery scab, silvery scurf, Rhizoctonia, and possibly other diseases, and thus give a better stand as well as a better crop. Details of this seed treatment are given under the headings: Potato Scab, and Rhizoctonia.

3. Keep the soil in good cultural condition from planting time until after blooming. Thorough and persistent cultivation not only helps to maintain the general health of the potato, but also is an important factor in reducing the amount of tip burn.

4. Spray the potato plants thoroughly with Bordeaux mixture (5-5-50) and arsenate of lead. The Bordeaux-arsenate spray is our most effective field treatment for late blight, early blight, and insects. It is also of some value in preventing tip burn. Do not forget the expressions: "Thorough spraying" and "Plants must be well coated". The plants should be sprayed at least four to six times, as mentioned in connection with potato late blight. The details in regard to preparing this spray material are given at the close of this bulletin.

TOMATO DISEASES.

Tomatoes are a crop of very considerable importance in West Virginia. Practically everyone who has a garden grows a few tomato plants, and there are many large fields where they are grown for canning and early market. Tomato diseases have been reported as very destructive in the southeastern part of the State and in 1913 the department of plant pathology was permitted to take up some definite investigations for the purpose of learning just what diseases were of most importance, their distribution, and possible methods of control. Work of this character is still in progress, but it seems well to include in this publication some general facts regarding tomato diseases.

Leaf Spot.—Tomato leaf spot (see Figs. 13 and 14) is prevalent throughout West Virginia. It has been found in every field or garden visited and is almost invariably present to such an extent as to result in serious loss. The disease is due to a fungus which produces dark colored spots on the leaves. The spots are usually from 1/32 to 1/16 inch in diameter, but may sometimes be larger. The younger spots may not be clearly visible until the leaf is removed and held to the light so that one can see through it. They are more or less circular in

outline and may often be so numerous as to result in a wilting of parts of the leaf. The lower leaves become affected first and they soon die and dry up. It sometimes happens that the disease will progress so rapidly that there will be only a few living leaves on the tip of each stalk. Such a reduction in the normal leaf surface is very injurious to the plant and is consequently accompanied by a serious decline in the amount and quality of fruit produced.

Fig. 13.—Leaf spot disease on tomato foliage.

Experiments conducted during the past three seasons show conclusively that this disease lives over winter in the dead leaves and vines. The destruction of any such refuse would therefore seem to be a matter of importance if tomatoes are to be grown upon the same or adjacent ground the next season. Spraying with Bordeaux mixture (5-5-50) has been tried at various times and places and is usually recommended. The plant pathology department has experimented with this spray and secured good results but it is believed that two or three pounds of good soap added to each fifty gallons of mixture make it more effective. The plants should be sprayed once in the seed bed, again as soon as they have begun to grow well in the field, and then **every two weeks until at least four or five applications have been made in the field.** The department is conducting further field experiments to determine the best method of control for tomato leaf spot.

Late Blight.—What has been said in regard to the potato late blight is almost equally applicable to the tomato late blight. The infections on leaf and stem are entirely similar to those on potato (see Figs. 15, 16, and 17). The disease also attacks the fruits producing a rot, and may usually be recognized by the somewhat streaky, cinnamon brown discloration of the affected part. In very moist weather the fungus may be found fruiting, as a white wooly growth, upon infected fruits.

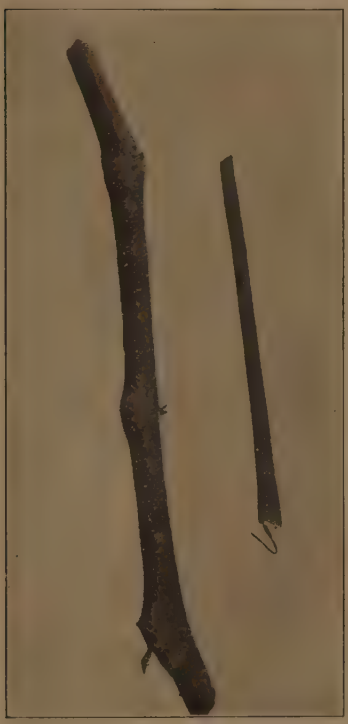

Fig. 14.—Leaf spot disease on tomato stems.

This disease has been particularly destructive in the southeastern section of the State. In many cases the vines were destroyed before any fruit had matured. It appears to be far more dependent upon weather conditions than is the leaf spot, and some seasons it may not be observed at all. Its occurrence and destructiveness vary greatly in different localities, but it is liable to ruin the entire crop in a short time if it gets well started in any field.

It is a little uncertain just how this fungus lives over winter, but some authorities state that it is carried to the tomato from the potato, and, of course, it lives in infected seed potatoes during the winter. The disease is quite readily controlled by timely and thorough spraying with Bordeaux mixture (5-5-50) as recommended for leaf spot.

Anthracnose. — Anthracnose is a fungous disease which is particularly injurious to the fruits. It is readily recognized by the presence of numerous, sunken spots (see Fig. 18). Such spots usually show a light gray center surrounded by a dark ring. The injury does not extend very deeply into the

Fig. 15.—Tomato crop destroyed by late blight.

flesh, but affected fruits are difficult to peel, frequently develop secondary rots, and are very hard to dispose of. The stems may also be attacked and in some cases the sunken stem spots may result in considerable injury to the plants.

Fig. 16.—Late blight rot. Fungus fruiting on tomato.

The trouble is very frequently encountered, although it is not nearly so common as either of the diseases previously mentioned. The writer has never happened to note it as being very severe in large fields. It is more likely to appear as destructive in small garden or truck patches. The reason for this peculiarity of its occurrence may be that there has not been sufficient crop rotation where these local outbreaks are found.

The fungus is believed to be carried over winter in diseased fruits and vines left in the field, and these should be destroyed if possible. Thorough spraying with the Bordeaux mixture (5-5-50) is said to be quite effective, but the department of plant pathology has conducted no experiments to determine this point.

Fig. 17.—Tomato late blight. Fungus fruiting on leaves.

Fusarium Wilt.—This disease (see Fig. 19) is very similar to the Fusarium wilt of the potato. The affected plants die comparatively slowly and may not show much actual wilting until they are nearly dead. The disease is general but does not appear to be particularly destructive.

The fungus lives over from year to year in the stalks and roots from diseased plants and in the soil where such plants have grown. Rotation and the de-

struction of trash in the field are consequently the only methods of control which seem practical at present. There has been some work done in an effort to find resistant varieties, and we may hope for some good results soon.

Bacterial Wilt.—This disease (see Fig. 20 and also bacterial wilt of potato) is due to bacteria which grow in the lower parts of roots and stems and clog up the little veins through which water and food material are conveyed from roots to leaves. The trouble is likely to be most noticeable after a prolonged period of warm, cloudy, rainy weather. Such weather keeps the plants full of moisture and the bacteria grow very rapidly. As soon as the sun comes out, however, the plants will show a more or less pronounced wilting, which first becomes apparent at the tips of the young growths. It often happens that the base of such a diseased stalk becomes soft and rotten, and in the earlier stages one may find that little drops of milky exudate appear on the cut surface if the stalk is cut off near the base.

Bacterial wilt has been found in various sections of the State and sometimes destroys a large percentage of the plants. The bacteria causing it are likely to remain alive in the soil for several seasons. Rotation should be practiced. Care should be exercised not to cut or trim a healthy plant with a knife or tool which has been recently used about a diseased plant, since the infection may be readily carried from one plant to another. Any such tools may be disinfected by dipping them for a moment in a solution of formaldehyde made up at the rate of one ounce to three quarts of water, or in a solution of Lysol made up at the rate of one and one-half ounces in one quart of water.

Damping Off.—It sometimes happens that many young plants in the seed bed wilt and die. Examination of such plants will show that the stem is diseased near the surface of the ground. The trouble is due to a fungus which thrives in moist, shaded soil. If practicable it is a good plan to bake thoroughly or steam the soil used for a seed bed. Too much water should not be applied, and the plants should be allowed as much

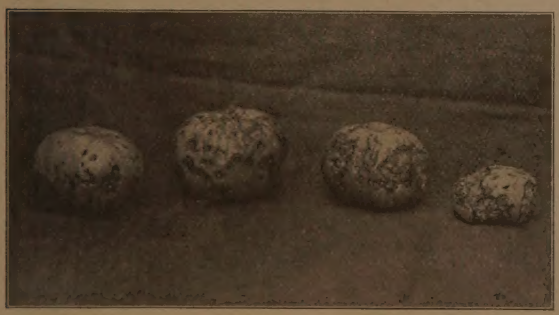

Fig. 18.—Anthracnose on tomato fruits.

sunshine and air as possible. Sprinkling hot, dry sand among the plants may sometimes help to check this disease.

Fruit Rots.—The tomato is quite subject to fruit rots of one kind or another. The rot due to late blight has already been discussed and those due to secondary fungi following anthracnose need not be taken up here. Several different fungi and bacteria have been mentioned by investigators in various sections of the country as the cause of tomato rot and it is quite likely that each one is correct for the particu-

Fig. 19.—Spot in tomato field killed out by Fusarium wilt.

lar case studied. Many of the earlier fruits produced are often rendered unmarketable by a peculiar form of point rot which seems in reality to be largely due to lack of moisture. It is considered a bad practice to use seed from plants which show much of this point rot.

The vital fact remains that there is little to be done for the prevention of such rots except to pick off and remove from the field any diseased fruits just as soon as they are noticed. Of course, the thorough spraying as recommended for leaf spot and late blight will help very materially in keeping down all rots due to fungi. There is also the hope that some good resistant varieties of tomatoes may be secured as a result of breeding experiments. [1]

General Recommendations

1. Either select your own seed from good fruits **on good plants,** or buy them from a reliable seedsman.

2. Give the plants **in your seed bed** plenty of sunlight and air, but not too much water.

3. Spray the plants **thoroughly** with Bordeaux mixture (5-5-50), preferably with the addition of two or three pounds of good soap to each fifty gallons. Spray young plants in seed bed once. Spray the plants as soon as they begin to grow well after setting in the field, and repeat the spraying at two-week intervals until four or five applications have been made. Good results will not be secured if the spraying is not done thoroughly.

4. Remove diseased plants and diseased fruits from the field. If the field is to be used for tomatoes the next season it might be well to destroy all dead vines.

5. Rotate the crops. Do not use the same piece of ground for tomatoes right along for several years.

Fig. 20—Bacterial wilt of the tomato.

6. The practice of staking up plants should result in less disease, but leaf spot is frequently found to be just as destructive on staked plants as on those lying on the ground. It is quite possible that this is because of the fact that the staked plants have been handled more and the infection carried on the hands, clothing, or tools from diseased to healthy leaves. It is believed that the question of staking or not staking is a matter which should be settled largely by a consideration of economic factors such as available space, value of land, value of crop, time or help which may be required, and various other items of that kind.

Preparation of Bordeaux Mixture

For preparing Bordeaux mixture the following proportions are recommended:

1 Experiments of this nature are being conducted at the Georgia Experiment Station.

Whale oil r... p...r better than ordinary soap to use with Bordeaux for tomatoes[1]

Copper sulphate, 5 pounds; unslaked stone lime, 5 pounds; water, 50 gallons.

Air-slaked lime should not be used. Since copper sulphate will corrode iron or tin it should be dissolved in a wooden or stone vessel. For making a barrel or less of the material, dissolve the copper sulphate in a pail of hot water, pour into the spray tank, and dilute to about 40 gallons. Slake the lime by the addition of the necessary amount of water and when slaked dilute to about five gallons of water. Pour the milk of lime thus made into the copper sulphate solution in the barrel, passing it through a strainer of brass or cheese cloth. Stir while adding the milk of lime and add water to make 50 gallons of spray material.

If much spraying is to be done with Bordeaux mixture it is desirable to have a mixing plant. This consists of a platform of such height that its bottom is a little above the opening into the spray tank. On the platform may be placed two 50-gallon barrels to hold stock solutions, one of copper sulphate and one of lime. The former is made by suspending 50 pounds of copper sulphate in a burlap sack in the top of barrel filled with water. This may be done at night and it will all be dissolved in the morning. The latter is made by slaking 50 pounds of stone lime in a barrel and when slaking is completed filling the barrel with water. One gallon of the contents of either barrel, when well stirred will contain one pound of the material mentioned in the formula. The platform also supports two other (dilution) receptacles, the combined volume of which equals the capacity of the spray tank. To fill the spray tank the required number of gallons is taken from the copper sulphate stock solution and placed in one of the dilution barrels and the required number of gallons is taken from the lime stock solution and placed in the other dilution barrel. Each is then diluted with the proper amount of water and the two liquids are allowed to run together by gravity, passing through the strainer into the spray tank.